SYMPOSIUM OP'24 ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Project

Generating prototype ocean initial conditions for the Weather-Induced Extremes Digital Twin

Introduction

Along many European partners, ECMWF is responsible for delivering the first digital twin of weather extremes (EDT), which relies on a fusion of observations and high-resolution versions of the Integrated Forecasting System (IFS), including coupling to the NEMO4-SI3 ocean and sea-ice model.

Accurate and timely initial conditions are of critical importance for skillful weather prediction. The ocean component of the EDT will use a global resolution of 1/12° (≤10km). Here we present a straightforward method for generating observation-constrained, high-resolution ocean initial conditions (ICs).

Method

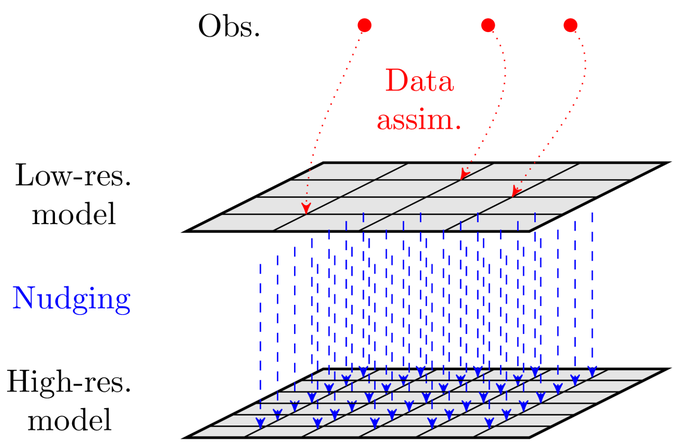

Fig. 1 *schematises how the method generally works.*

- Two-step, indirect "integration" of observations into the model:
  1. Data assimilation: model + observations provides "reference" dataset, taken as input in that context.
  2. Ocean and sea ice (categories carefully accounted for) stand-alone run with nudging to this reference provides "**strongly constrained**" (i.e., data assim.-like) ICs.
- Sea-ice cover and subsurface ocean are more constrained than with **surface relaxation only**.
- For example, on Fig. 3, 3rd row weakly constrained, 4th and 5th strongly.
- Testing **ECMWF subseasonal forecasting system** (for which the ocean is expected to have more impact), comparing 1/4° with 1/12° NEMO with similar ICs.
- The GLORYS12v1 ocean reanalysis is here used as a reference, but method is **flexible** and **data-agnostic** (other datasets also succesfully tested).

Results

- Nudging-based method efficient for generating **bias-reduced ICs**.
- Forecasted ocean mean state and prediction skill **slightly improved** when coupled to higher-resolution NEMO.
- At daily to monthly lead times, impact of 1/12° is **reduced** when initial states are strongly constrained to the **same product**.

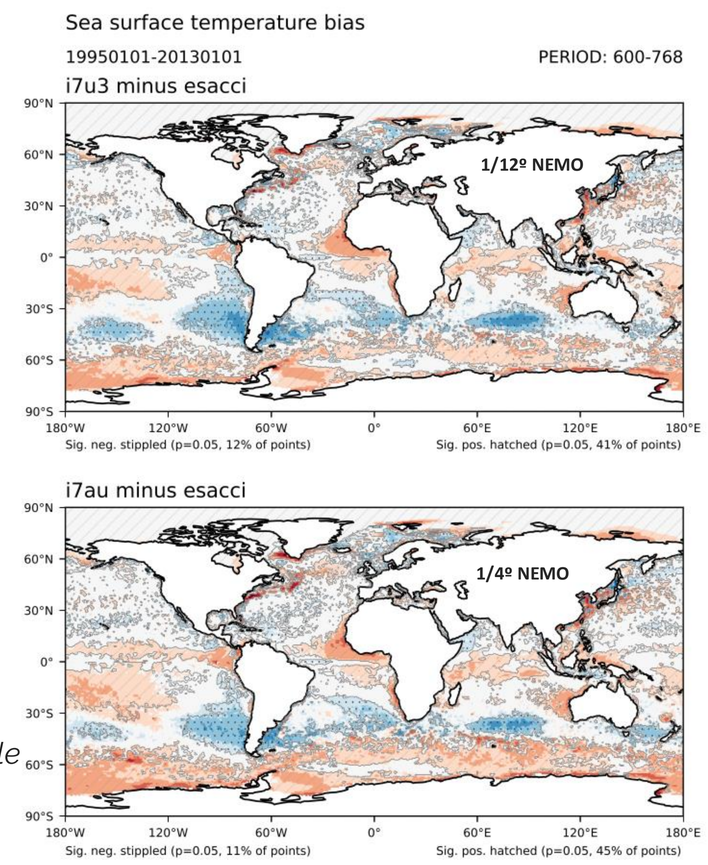

Fig. 2*: mean sea-surface temperature biases at lead times 24 to 32 days for 1995-2013 reforecast using comparable 1/12° (top) and 1/4° (bottom) NEMO configurations.*

Future developments

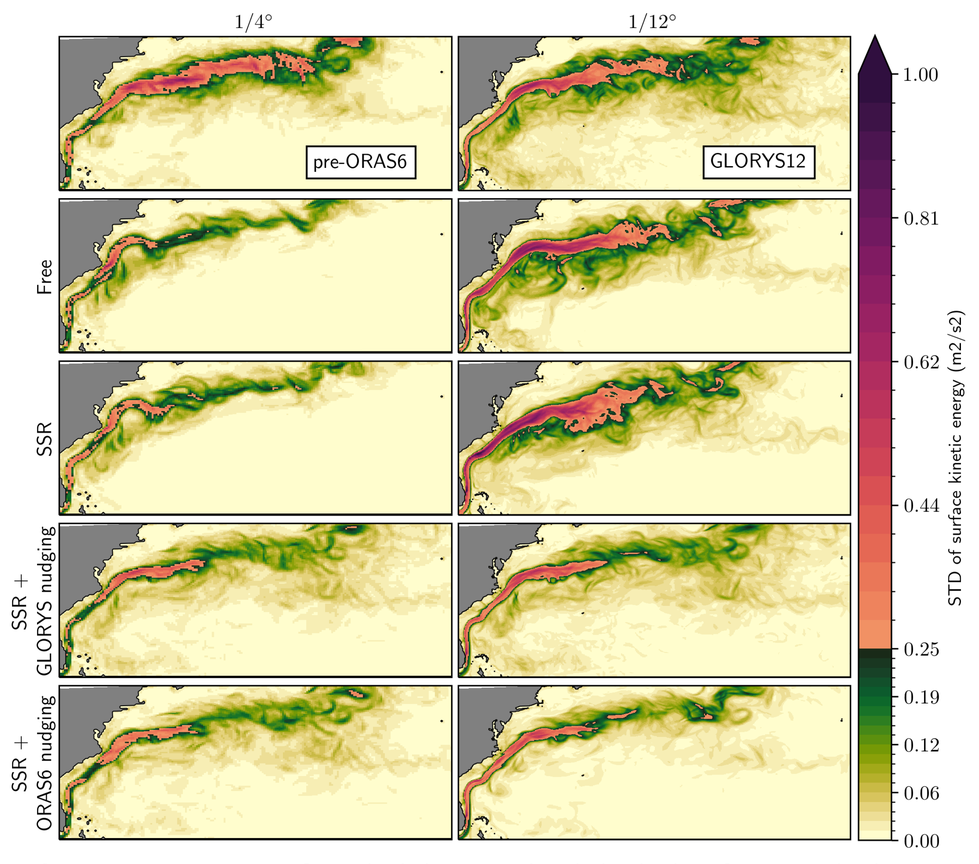

Fig. 3*: mean sea-surface height standard deviation for stand-alone 1/4° and 1/12° (left and right, resp.) ocean experiments. using various types of observation-constaints (rows).*

- Nudging inherently **damps internal variability** (including the daily cycle).
- Preliminary work ongoing on reducing that drawback, inspired by data assimilation:
  1. **Passively** evaluate model departure at every time step.
  2. Apply **time-averaged increments**.

Conclusions

- Exploring **prototype higher-resolution ocean configuration** for coupled predictions.
- Similar results obtained for **medium-range testing** (5-15 day, not shown here).
- **Pre-operationalising** the method, aiming towards coupling this ocean configuration to 4km-atmosphere as part of the EDT.

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